Phys. 163; Homework Set #1: Due Tues 9/5

Note: Problem #3 is worth 5 points, out of 10 points total.

1) Suppose that both $\Psi_1$ and $\Psi_2$ are both normalized solutions, and also suppose that $\int_{-\infty}^{\infty} \Psi_1^* \Psi_2 dx = 0$ at all times (the technical term for this condition is that $\Psi_1$ and $\Psi_2$ are "orthogonal"). For any two complex numbers (a,b), show how to normalize the wavefunction ($a\Psi_1 + b\Psi_2$). Remember: a and b can be complex; your answer should reflect this.

2. Normalize the following instantaneous wavefunctions (or prove that they're unnormalizable, if that's the case.) Look up any integrals you need.

A) $\psi(x) = \sqrt{\dfrac{1}{1+x^2}}$

B) $\psi(x)=(a-|x|)$ if $-a<x<a$, but zero outside this range. ("a" is a constant.)

C) $\psi(x)=A(x)+2B(x)-3iC(x)$, where A(x), B(x) and C(x) are all independently normalized and are also orthogonal to each other (see problem 1 above).

3. Problem 1.9. Look up any integrals you need. (Do a search for "Gaussian integral", or look at the back flap of your textbook! If the integrals you find only go from zero to infinity, be careful about simply "doubling" your answer; sometimes the negative x integral cancels the positive x integral, in which case you don't have to integrate at all!) Since this wavefunction is a function of time, you can use the shortcut in equation 1.33.

4. (From chapter 2): Consider a superposition of stationary states, as shown in Eqn. [2.16]. (Each stationary state $\psi_n$ solves the Time-Independent Schrodinger Eqn., with some corresponding energy $E_n$.)

Assuming all the stationary states are "orthogonal" (as in problem 1), and they are all independently normalized, calculate what the standard Normalization condition implies for the total superposition as a whole. (Hint: your answer should simply be a condition on the complex coefficients $c_n$. Another hint: If you have two sums in the same expression, use a different index for each one, or else you will get confused with too many "n's" floating around that mean different things!)